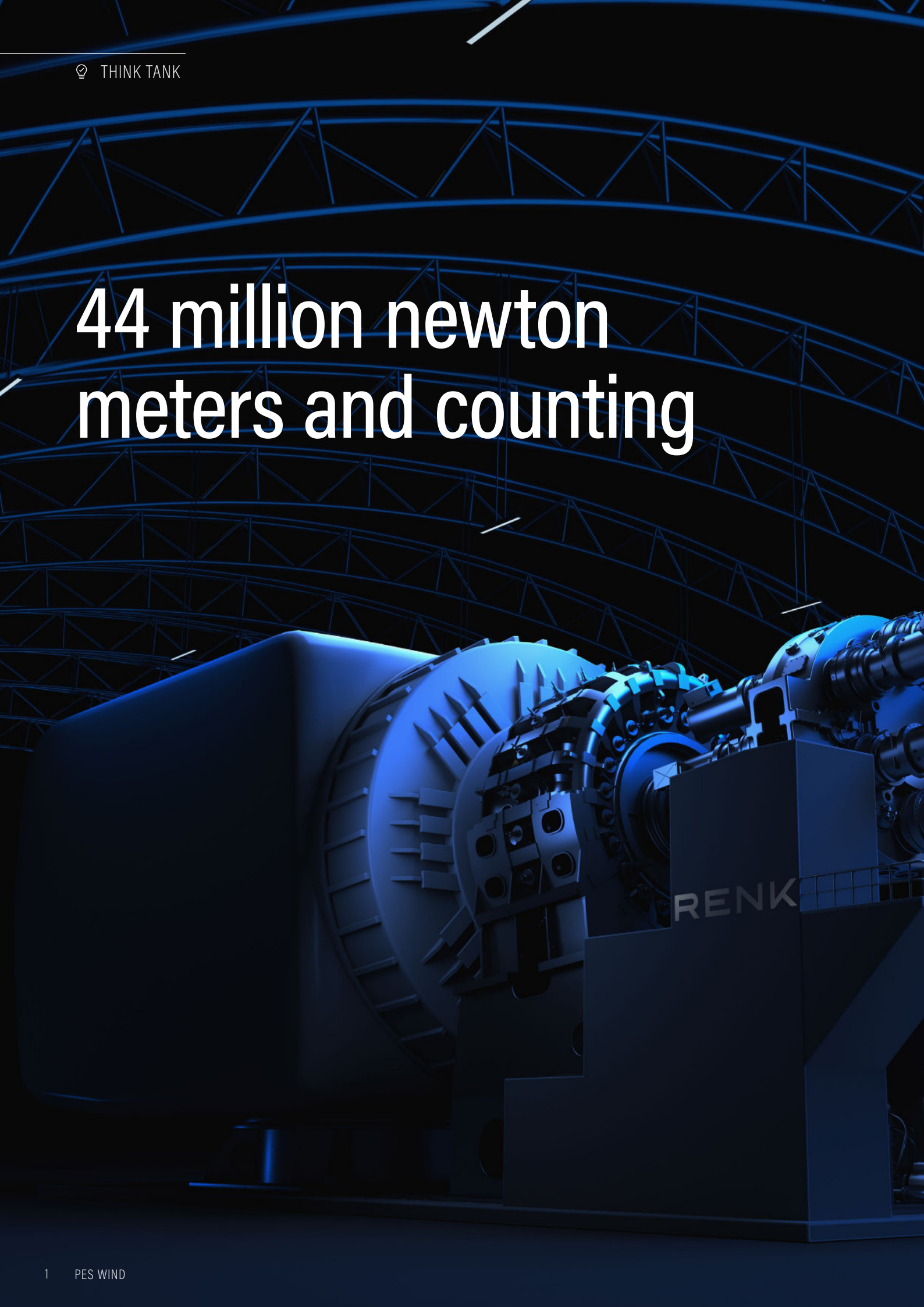
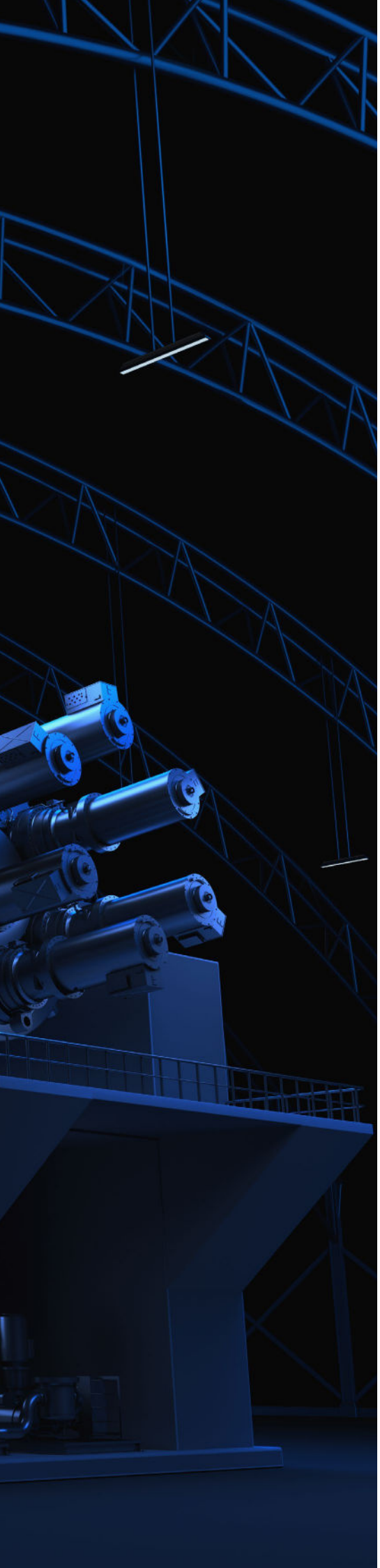
44 million newton meters and counting





Currently, the advancement of dependable wind turbines heavily relies on the continuous utilisation of test rigs. Thus facilitating the alignment of calculations and simulations at both the component and system levels, ensuring a seamless progression in turbine development. One notable contributor in this field is RENK Test System GmbH.

Offshore wind turbines have seen a veritable explosion in performance in recent years. And since the development of such turbines is not possible without appropriate testing technology, the corresponding test rigs for wind turbines have followed this performance explosion too. When Clemson University in the US opened its Wind Turbine Drivetrain Testing Facility, now known as the Dominion Energy Innovation Center, in 2013, it was the most powerful wind turbine testing centre in the world by far. Equipped with two test rigs from Germany's RENK Test System GmbH (RTS) in the 7.5 MW and 15 MW power ranges, the size of the test centre seemed overstated at the time.

Today, the plant capacity is at the limit and new test centres, which will be built on different continents in the next few years, will have test capacities of well above 30 MW, due to demand to test increasingly larger wind turbines.

These test capabilities are mainly used for development tasks to upgrade existing turbines and to develop new ones. Performance tests under full load require the maximum turbine output. Special test procedures with excessive loads are carried out to simulate the 20 year service life.

For future test rig developers, the challenge lies in sourcing test rig drives that meet the upcoming demands. The primary difficulty isn't centered around the electrical power of the drive; rather, it's focussed on achieving the necessary torque. The testing of forthcoming low-speed offshore turbines will necessitate torques exceeding 40 million newton meters (MNm). Unfortunately, conventional motors capable of delivering such immense torques are presently unavailable.

For this reason, RTS, one of the leading manufacturers of customised test rig solutions, has developed a new multi-motor drive that is precisely adapted to the future requirements. The concept of the multi-motor drive is used for applications where extreme torques and maximum operational reliability are required. The arrangement of several electric motors to form a single compact drive system enables a resulting torque that is otherwise only possible with risk- and cost-intensive special solutions in motor construction, such as direct drives. The arrangement of several standard motors in combination with proven RENK gear technology, on the other hand, results in a system of highest reliability and low cost.

For the RENK Group, it is a common approach to combine multiple electric motors with one gear unit to meet extreme customer requirements. For marine applications, for example, the company has developed the Integrated Front-end Power System (IFPS®), in which several generators can be flanged to the ship's diesel engine in a compact unit to generate electric power. For powering giant vertical mills, it offers the Compact Planetary Electric Drive (COPE®). The technology of multi-motor drives is very mature at RENK and has been tested in a wide variety of applications.

The primary task of the main drive of a test rig is to simulate the rotational working conditions of the test specimen in the field as realistically as possible. In the case of a wind turbine test rig, these are turbulent wind conditions that lead to very powerful and dynamic load conditions. In addition, there are tasks such as the simulation of the resonant frequency of the real drive train of the wind turbine with rotor on a test rig without rotor, the simulation of emergency stops and abrupt voltage changes, where dynamic torque changes occur.

Depending on the test, this results in highly dynamic requirements for the drive as well as sign changes for the torque. The largest member of the RENK multi-motor drive family to date is now taking shape for precisely this application.

When fully assembled, the drive will have a diameter of approximately 6.6 m and be around 10.2 m long. Its weight will be approximately 450 tons. The heart of this multi-motor drive is the central gearbox to which up to 12 electric motors can be attached. The gearbox output shaft transmits the total power to the main shaft of the test specimen. Equipped with 12 standard AC motors of 2.9 MW each, this multi-motor drive provides a maximum rated torque of 44 MNm, and even more for a short time for acceleration processes.

This extreme power density is achieved by the very high development and manufacturing competence within the RENK Group and reliable teamwork of various operating facilities. Test bench technology, gear and motor technology, plain bearings, couplings, sensor technology and development of in-house control systems. These are subjects, where RENK is active in and respected in a wide range of industrial sectors.

The new drive developed this way has several advantages, including impressive power density. Equipped with 12 motors and a nominal torque of 44 MNm, this drive has an extremely low weight to torque ratio of about 10.2 t/MNm. Similar direct drives weigh about three times as much. Small dimensions and low weight are not only advantageous for transport and assembly, but also have a decisive influence on the design of the test rig foundation and the overall costs.

Simple power upgrade is another advantage. Due to the rapidly advancing development time of new turbine generations, the use of a nacelle test rig requires large power reserves need to be kept available. The multi-motor drive can initially be operated with a reduced number of motors and later easily upgraded according to performance requirements. This enables lower procurement and maintenance costs and always only as much drive power as is currently required.

A further benefit is high reliability. The RENK multi-motor drive system has been used for many years with great customer satisfaction. A large number of the components used, such as motors and electronics, are standard components. Important parts such as gear units, plain bearings and couplings are manufactured in-house at RENK to the very highest standard.

A final advantage is maximum redundancy. The drive system is still operational even if one or more motor units are removed, just with less power. This ensures very high availability of the entire drive system in the event of component failures.

When developing this new multi-motor drive, the experts at RENK also specifically focused on the dynamic requirements resulting from the wind-typical test runs of a nacelle test rig. For the dynamic control of drive trains, the control bandwidth is the decisive criterion. This results from the torque actuating times of the drive and the transmission of torque via the drive train. To increase the dynamics of the drive system, RTS uses very special customised state space controllers. By simulating the entire drive train from the test bench switch cabinets to the nacelle transformer as a digital twin, the unrestricted suitability of the multi-motor drive is demonstrated for a wide range of standardised and customer-specific wind load cases.

This perfect suitability of the multi-motor drive to perform high torque, highly dynamic test runs combined with the other advantages such as lightweight, reliability and availability make this drive system just awesome.

The first customer for this new 44 MNm multi-motor drive is Gyeongnam Technopark (GNTP) in Changwon-Si, South Korea. The Korean government's '3020 Plan' aims to increase renewable energy production to 20% by 2030. GNTP is a public research institute and plans to enhance the technical capability of South Korea on the topic of renewable energy production, especially wind power. The focus is on the installation and operation of the most powerful nacelle test rig ever built, to test wind power nacelles with a nominal power of up to 20 MW.

RENK COPE drive

Casting of the upper half of the housing of the 35 MW multi-motor drive system

This project is divided into two phases: In the 'Basic Stage', which is configured to test wind turbines up to approximately 15 MW, the multi-motor drive is only equipped with a reduced number of standard motors and is thus limited to 23.2 MW.

In a second project phase, the 'Extension Stage', the missing standard motors will then be installed and thus the full capacity of 34.8 MW will be achieved. In addition, a hydraulic load application unit (LAU) will be added in the second phase in order to be able to map all static and dynamic wind loads 6DOF. Commissioning of the Basic Stage is planned for the end of 2024. The upgrade to the Extension Stage will take place when tests of nacelles up to 20 MW are required.

Moreover, while this project is in progress in South Korea, the specialists at RENK Test System GmbH are already working on the next generation of the multi-motor drive up to a torque of 60 MNm. The need for even larger wind test rigs can already be seen in the wind energy industry.

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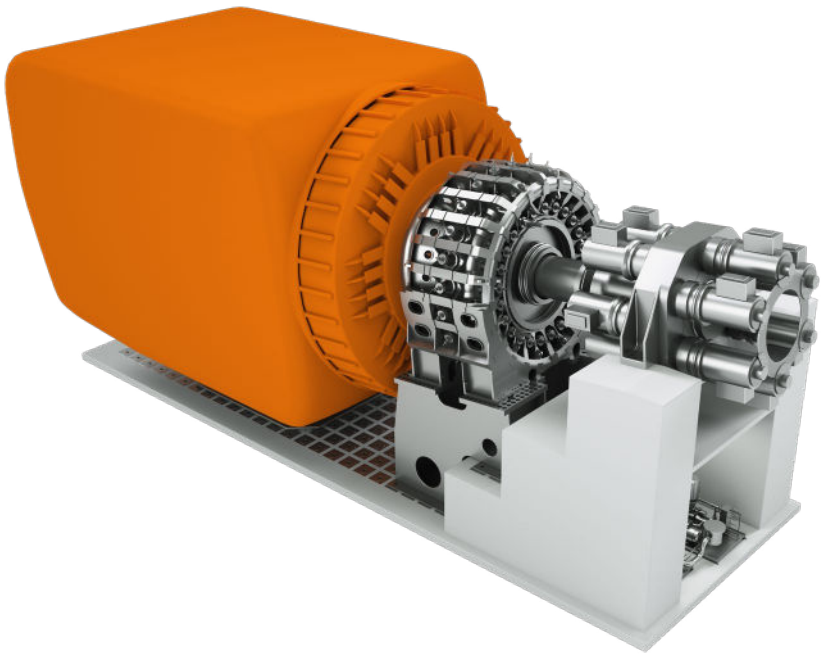

35 MW nacelle test rig for GNTP with new multi-motor drive system